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By John R. Johnston.

With a Plate.

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By John R. Johnston.

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The remarkable fungus which forms the subject of the present paper was described under the name *Lycoperdon transversarium* as early as 1811, by M. Bosc (3). It has since been reported only occasionally, and the numerous descriptions of it which exist are mostly copies of previous ones, no further information having, up to the present time, been available in regard to its structure or development than is contained in the early description of Bosc.

Through the kindness of Professor Thaxter, I have had the use for study of alcoholic and of dried material of this form, which was collected by him in Florida during the month of October, and which included both mature and young specimens.

General Structure.

The mature specimens examined are club-shaped, stipitate, and olive-brown; from three to seven centimeters in height. They vary from narrowly to broadly clavate, that is, from 1.5 cm. to 2.5 cm. in diameter, in specimens of the same length. Fig. 2 represents a narrowly clavate form with fibrillose base; in fig. 3 is illustrated an individual with a much greater diameter, the base being expanded for attachment to the substratum. The stipe is distinguished usually as the narrowed base of the fruiting body and by its whitish color. The peridium is simple; it ruptures irregularly and indefinitely, and covers the entire gleba. It consists of loosely interwoven hyphae, which become spread apart at various points, exposing the chambers of the gleba beneath (figs. 3 and 11); and in some mature specimens is even more or less evanescent, the exposure of the glebal chambers giving a honeycombed appearance to the entire surface. An area of this nature, in which the characteristically anastomosing glebal folds are thus exposed, and in which the

chambers are in free communication with the air, is shown, considerably enlarged, in fig. 11. The peridium, which thus encloses the gleba often more or less incompletely, is further continuous with the columella where it emerges at the apex (fig. 10) and also below with the stipe.

In the interior of a typical specimen, the columella, which is a direct continuation of the stipe, runs to the apex and is externally visible, either as a more or less orbicular depression or a slight elevation. Though this is usually at the apex of the body, it is sometimes a little at one side (fig. 5). The firm sub-gelatinous axis consists of branching hyphae closely interwoven, and running more or less parallel. From the columella proceed the tramal hyphae toward the peridium. In a section of a mature specimen the tramal plates appear to branch and anastomose so as to form closed chambers, while from the trama arise many hyphae which bear basidia in groups (figs. 14, 15). The basidia, growing at right angles to the trama, form, as usual, the hymenial layer which lines the chambers (z′, fig. 7). The gleba (z) is thus formed between the peridium (x) and the columella (y), and consists of a series of chambers which appear to be more or less continuous with one another, and are lined with typical 4-spored basidia. The spores are brown, smooth, ovate to elliptical, borne on well-developed sterigmata, and without any distinguishing peculiarities. Usually each basidium (fig. 15) has at least a basal septum, and in some cases there are also indications of one more or less median septum.

Development.

Alcoholic material was used in studying the young stages. About a dozen specimens, ranging from 3 mm. to 8 mm. in height, were imbedded in paraffin, and cut into sections 10 μ thick. For staining, Haematoxylin, Safranin, and Bismark Brown, were employed, the Haematoxylin giving better results than the two others. Dried material soaked in potassium hydrate and picked apart under a dissecting microscope, showed the groups of basidia, their form and septation, very clearly.

The youngest specimens examined, which were merely pointed upgrowths from the running mycelium, showed no indication of differentiation. In a specimen 3 mm. long, for example, there is no differentiation of gleba, but simply a loose interweaving of superficial hyphae which is the first indication of a peridial layer. There is also in these specimens, at their apex, a sheaf-like spreading of the parallel hyphae, which is very marked in the older ones (figs. 8 and 9).

The youngest stages examined in which any differentiation of importance was observed is represented in fig. 8, in which a distinct layer (x) of interlacing hyphae covers the more compact columella (y). Between the two is a deeply staining region (z) running lengthwise with short folds. This layer may be seen to consist of the tips of hyphal branches arranged in a columnar fashion, closely packed, and arising from a looser indefinite region below, which is made up of branching hyphae proceeding directly from the columella. This compact, deeply staining layer, which is the initial gleba, has no connection with the peridium lying next to it, but becomes gradually merged at both ends into the hyphae of the columella. The peridium is thus pushed away from the axis of the fruiting body by the growing gleba; and its further growth, which is relatively inconsiderable, is independent of the structures which it surrounds. At the base and the apex of the fruiting body, its connections are a little more evident. At the apex the peridium is indistinctly differentiated from the columella, and though the hyphae of both anastomose in this region, this differentiation becomes more marked with further growth; not to the extent, however, of final separation. At the distal end of the stipe the hyphae of the peridium and of the axis are closely intermingled, anastomosing freely, as do also the hyphae of the peridium with those at the apex of the columella; the distinction between the axil and the peripheral layer in each case lies in the fact that the hyphae of the axis constitute a firm coherent mass, while the hyphae of the peridium form a thin flocculent layer. These conditions are represented in fig. 13, which is an enlarged view of a portion of fig. 8 at the apex of the fruiting body. The fact that the initial gleba (z) is not connected with the peridium (x) and arises from the columella (y) is clearly shown in this figure. Here, too, the columnar layer extends gradually into the columella near the apex, at the right in the figure which here includes the ill-defined region of separation between the peridium and the columella. At this point there are thus clearly distinguished in this stage three regions: the peridium, the gleba, and the columella; the gleba consisting as yet merely of folds from the surface of the columella which result from the more rapid multiplication of the elements of the columnar layer in one part than in another.

In a somewhat older stage (fig. 6), these three regions are seen to have been still more clearly differentiated from one another. Distinct groups of hyphae run out from the columella into the folds the surface of which, as previously mentioned, consists of a layer of columnar elements. As the fold pushes farther out and its surface increases, new columnar

cells are constantly coming to the level of the rest in the formation of the hymenial layer. Secondary folds arise from the primary ones by a similar process of development which ceases only at the maturity of the fruiting body. A repetition of this folding, which causes the trama to appear branched in section (fig. 7), results in a general enlargement of the gleba while the peridium is pushed farther away from the columella, the gross form of the plant becoming thus changed from almost columnar to broadly clavate. This excessive growth of the gleba causes it to equal or to exceed the columella in thickness within the very thin peridium, a condition presenting a distinct contrast to that of a younger stage, in which the peridium as well as the columella is much thicker than the gleba.

Little has been said as yet in regard to the growth of the peridium and its conditions at maturity. That it originates from the part of the mycelium which was not differentiated into central axis and gleba has been already mentioned, and also that its development after this differentiation is independent of the development of axis or gleba. With the increase in the size of the gleba is associated a corresponding increase in the extent of the peridium, which does not, however, become any thicker. In mature specimens it is exceedingly thin in comparison with the columella, so that at the apex the continuity of the two regions is very inconspicuous (fig. 5); and even in so young a stage as that represented in fig. 7, it is only the peripheral hyphae of the columella and of the peridium which anastomose at the apex. The distinction between the two regions about the stipe also is clear in this figure. From the fact that in some mature specimens (fig. 2) the relatively exceedingly thin and delicate peridium is continuous over the gleba, one must assume that its growth has kept pace to a certain extent with that of the elements within it. In a majority of specimens, however, (fig. 3) the chambers are more or less exposed in places, as if excessive growth within had stretched the peridium and finally caused it to become pulled apart over certain areas. This condition is probably further accentuated by the irregular wearing of the delicate weft which constitutes the peridium in the older stages; and in some specimens the honeycombed surface of the gleba may be almost entirely exposed.

This partially exposed condition of the hymenial region is no doubt connected, in a measure, with the dissemination of the spores, many of which must, in such cases, be discharged directly into the air. Observations made by Dr. Thaxter in the field on abundant material in all conditions of development show, however, that with the exception of this limited dispersal from the more or less exposed glebal chambers, no

means of dissemination appears to exist except such as may be accomplished by the ultimate decay of the mature plant or its possible ingestion by animals. The history of the gleba in this respect is thus wholly similar to that which characterizes the Hymenogastraceae in general, a powdery condition occurring only when the glebal mass has dried after decomposition. It may be mentioned that in the locality examined by Dr. Thaxter it was noticed that this general decay was often hastened by the attack of the parasitic *Sepedonium chrysospermum*.

To sum up the development of the fruiting body: the upgrowth from the mycelium is differentiated into a cortical and a medullary layer. The cortical layer becomes the peridium, whose further growth is independent of the medullary layer, from which it differs in the arrangement of its hyphae, in that they form a loose irregular network instead of running more or less parallel to form a firm subgelatinous mass. The medullary layer becomes the stipe and the columella, with which the hyphae of the peridium are continuous. The surface of the columella becomes differentiated into folds which form the gleba. The surface of these folds consists of columnar elements which constitute the basidia of the mature specimen.

History.

This species was first described as *Lycoperdon transversarium* by M. Bosc (3) (1811), as follows:

"Vesseloup Transversaire. V. sessile en forme de massue irrégulière, traversée par un axe conique, de contexture fibreuse qui part des racines et se termine au sommet.

"On rencontre cette espèce dans les bois sabloneux de la basse Caroline, mais elle n'est nulle part commune. Sa forme la rapproche de la Vesseloup pistillaire et son axe de la Vesseloup axate que j'ai décrite et figurée dans les mémoirs de la société d'histoire naturelle de Paris. Sa masse est composée, comme dans les autres vesseloups, d'un reseau très serré entre les mailles duquel sont nichées les semences, mais j'ignore si elle s'ouvre au sommet ou sur les côtés pour les repandre. Je crois que ces caractères suffisent pour en faire un genre nouveau dont feroit partie ma vesseloup axate."

This description, as well as the drawing which accompanies it, answers very well for the plant under consideration, although the latter is merely an outline of the specimen, indicating its club-shaped form.

In 1829 Elias Fries (10) transferred the *Lycoperdon transversarium* of Bosc to the genus *Cauloglossum*, Grev., giving the generic characters

of *Cauloglossum*, and referring in his Syst. Orb. Veg., I. p. 136, to *Schweinitzia* Grev., as a synonym. An explanation of this is found in a paper by Greville (13) entitled "Observations on a New Genus of Plants belonging to the Natural Order Gastromyci," published in 1823, in which he describes the genus *Schweinitzia* as follows: "gen. char., *peridium stipitatum ad basin dehiscens. Stipes percurrens.*" Under this he includes two species, *S. pistillaris*, the type, synonymous with *Scleroderma pistillare* Pers. (*Lycoperdon pistillare* L.); and *S. carcinomalis* synonymous with *Scleroderma carcinomale* Pers. (*Lycoperdon carcinomale* L.). These two species, from the characters of the genus and their synonymy, will be readily recognized as forms which are correctly placed at present in the genus *Podaxon*. A few months later Greville published the following note in the Scottish Cryptogamic Flora (14): "In the 8th volume of the Edinburgh Philosophical Journal, I proposed to name a most curious new genus of *Gastromyci*, SCHWEINITZIA, after the above mentioned excellent botanist. I have since ascertained that a genus of phenogamous plants has been recently dedicated to him by Mr. Elliot. I wish, therefore, to substitute the name *Cauloglossum*: the character is *Peridium stipitatum ad basin dehiscens. Stipes percurrens.* The species are *C. pistillare* and *C. carcinomale*, both imperfectly described by Persoon (24) in his Synopsis Fungorum, under *Scleroderma*." It is thus evident that the name *Cauloglossum* was given to a genus which included only the two species just mentioned, both of which are at present correctly placed in *Podaxon*. Since the genus *Cauloglossum* is thus a synonym of *Podaxon*, having been originally proposed for the reception of forms generically quite distinct from *C. transversarium*, as has been shown in the preceding account, its use in the present instance would lead to confusion, and it has therefore seemed desirable to examine in some detail the further literature and synonymy relating to it.

In Fries's Systema Mycologia (10), in which, as above mentioned, *Lycoperdon transversarium* Bosc, is first referred to Cauloglossum, Greville's description of that genus is reproduced without modification, and the following synonyms are given: *Cauloglossum transversarium* Fries (Bosc): *Penis caninus virginianus*, Pluk. phyt. t. 184. f. 6.? (Cfr. *Spadoniam*): *Lycoperdon transversarium*, Bosc and Nees: *Cionium Carolinense* Sprengel. (*Herculea* Fries., inscr.).

The record in the reference to Plukenet (25) (1720) reads thus: fig. 6: "*Fungus phalloides, parvus, s. Penis caninus Virginianus;* D. Banister." The plate shows a figure of an erect specimen of almost

the same diameter throughout, but with rounded and scaly ends, and is altogether too meagre a drawing to admit of any definite determination. It is probably the phalloid, *Cynophallus caninus.*

The third citation, Nees (23), refers merely to a copy of Bosc's figure under the name *Lycoperdon transversarium* Bosc.

Cionium Carolinense, which is further referred to by Fries as a synonym, is described by Sprengel (28) as follows: "*Cionium carolinense*, sessile oblongum irregulare glabrum, columella elongata. *Carolina* (Lycoperdon transversarium Bosc)." The characters of *Cionium*, however, as given by Link (17) who instituted the genus, do not justify Sprengel in making this reference, as is manifest from the following description: "*Cionium. Sporangium subglobosum, aut difforme. Peridium simplex, membranaceum, rumpens, squamulatim fatiscens. Flocci intus versus basin adnati. Columella intra peridium. Sporidia coacervata.*

"Sporangium prima aetate molle. . . . Sporidia majuscula, globosa, plerumque atra. Hujus loci Didymium complanatum, farinaceum."

Finally the only reference to the name *Herculea* is that of Fries (9), where he simply states that he had, in preparing his manuscript, called the genus containing the species "*elatum*" and "*transversarium*" *Herculea*, but that Greville had forestalled him by the publication of the name *Cauloglossum*, which should stand.

In the Genera Plantarum, 1836, Endlicher enumerates among the Gastromycetes *Cauloglossum transversarium* Fries.; while Fries again in 1845, writing on the vegetation of Scandinavia, mentions *Cauloglossum* Fr. under the Podaxinei, a group of the Lycoperdaceae. He places the name in brackets, intending doubtless to indicate that it is not found in Scandinavia.

In the Vegetable Kingdom, 1853, John Lindley includes *Cauloglossum* Fr. under the Podaxinei.

Another and fuller record by Fries (12) is to be found in the Nov. Symb. Mycol. 1857: "*Cauloglossum transversarium.* S. M. III, p. 61. In Carolina, Curtis, et in Mexico. Secundum haec specimina juvenilia a *Secotio* hoc genus tantum differt peridio clavato et stipite contiguo, observante jam Berkeleyo. Habitu et facie adeo exacte convenit cum *C. elato*, exoleto modo lecto, ut de genericu identitate non dubitem."

In Grevillea (1), 1873, is the following record:

"Cauloglossum transversarium Fr. Car. Inf. No. 267. In wet, sandy places. Dull brownish yellow." M. J. Berkeley.

In Grevillea (4), 1878, a further record reads thus:

"Cauloglossum transversale Fr. — Rav. Fung. Amer. No. 13. In moist woods. Gainesville, Florida." M. C. Cooke.

In the Curtis Herbarium at Harvard University the species is represented by the following specimens: "*Cauloglossum transversarium*. ad. terram arenosam ad margines sylvarum Nov. 1846: Wilmington, N. C." "*Secotium transversarium* B. & C., Tuskegee, Ala., aestate, 1853, Beaumont (31)." "*Cauloglossum transversarium;* Pinetis arenosis. N. Cesaraea, C. F. Austin (166)." "*Cauloglossum transversarium* Fr., Santee Canal, S. C., Ravenel."

In the Ellis Herbarium at the New York Botanical Gardens is a specimen of *Cauloglossum transversarium* collected near Wilmington, North Carolina, in November, 1880, by Dr. Thos. F. Woods. In a letter* Dr. Woods says, "It grows along the moist margins of a mill-pond near Wilmington in a loamy soil under thin undergrowth."

C. L. Shear (27) in an article published in the Asa Gray Bulletin, 1899, practically repeats the early description of Bosc, having obtained no new data or specimens upon which to work. He has, however, taken the generic description from that of Zobel (29) in Corda, which was a modification of Greville's description made to suit *C. aegyptiacum*, a form entirely different from *C. transversarium*, so that as a result Mr. Shear really attributes to *C. transversarium* some characters which it distinctly does not possess, as "basidia (?) stellate-glomerate" and "base (of stipe) clothed with the rudiment of the volva, which is incomplete and coriaceous."

The last record concerning it which I have at hand is that of Dr. Thaxter in 1897 at Eustis, Florida. Dr. Thaxter's notes read as follows: "abundant material was found growing out of the bases of living or dead trees or upon rotten stumps or fallen logs of *Pinus palustris* Mill., or among rubbish on the ground close by. When young the gleba is dirty gamboge yellow; when exposed by injury becoming dirty olive brown, eventually dark. Externally dirty brownish or buff yellow. Stem nearly white."

An examination of all the records obtainable thus indicates that the plant under consideration is identical with the *L. transversarium* of Bosc, and it is further evident that its reference by Fries to *Cauloglossum* was incorrect, since the last mentioned genus including its

* For the quotation from this letter and a portion of one of Dr. Woods's specimens I am indebted to Prof. F. S. Earle of the N. Y. Bot. Gard.

synonyms *Herculea* Fries and *Schweinitzia* Grev. is a synonym of *Podaxon*. *Cionium* Lk., the only other generic name that has been applied to it, represents a plant of an entirely different character, undoubtedly referable to the Myxomycetes. In view of these facts it seems necessary to propose a new generic name for this form.

In order to determine whether species other than *C. transversarium* should be similarly treated, it seems desirable in this connection to examine the published data which are available concerning *Cauloglossum elatum* Fr., *C. aegyptiacum* (Mont.) Zobel, and *C. novo-zelandicum* (Henn.) Fischer, which appear to be the only forms, with the exception of the two species of *Podaxon* and the *Penis caninus virginianus* Plukenet already mentioned, that have ever been referred to *Cauloglossum*.

Cauloglossum elatum, a form occurring in East India, is described by Fries (10) as possibly synonymous with *Clavaria pistillaris* Lour. (19). In general form and in the presence of an axil columella it resembles *C. transversarium*. In the minor characters, its white color, small size (only half an inch in height), it seems to differ distinctly, while the fact that the peridium falls away, only scaly remnants being left at the base and apex, separate it clearly from *C. transversarium*, and suggests that it belongs rather in the Podaxaceae.

Cauloglossum aegyptiacum (Mont.) Zobel, which was originally described under *Podaxon* by Montagne (22), is figured and described in Corda (29). Zobel, however, modified Greville's original generic description of *Cauloglossum* by adding the following points: "basidiis (?) stellato glomeratis; . . . stipes firmus, erectus, basi rudimentis volvae vestitus. Volva incompleta, cum stipite connata, coriacea." A species to which such characters apply cannot be included in the same genus with *C. transversarium*; and it seems probable that Montagne was right in placing it in *Podaxon*. It is a form that has been reported but once, by M. Bové, from the lands between Suez and Gaza.

The last form that has been placed under *Cauloglossum* is *Clavogaster novo-zelandicum* described by P. Hennings (15) and referred to *Cauloglossum* by Fischer. *Clavogaster* was a new genus proposed by Hennings for a New Zealand form, the characters of which he described as follows: "Perithecium subcoriaceum, persistens e stratis binis discoloribus efformatum, clavatum, stipitatum. Capillitium subfasciatum in cellulas favosas, polyedras, sporis levibus, ellipsoideis, coloratis, pedicellatis. *Hippoperdo* paraffinis."

In view of the fact that the presence of a capillitium and the absence

of a columella seem sufficient to exclude such a form from *Cauloglossum* as heretofore understood, it is not clear why Professor Fischer should have changed the name employed by Hennings, who, moreover, could hardly have omitted all reference to a columella were one present in the species.

Whether the name *Clavogaster* should stand, or should be considered as synonymous with some other genus is, however, of no importance in the present connection, since the type species seems widely distinct, generically, from the form under consideration.

It is evident, then, that, in so far as can be determined by published data concerning them, none of the forms which are above referred to can be properly associated with *Cauloglossum transversarium*, which at present must be considered to stand as the only representative of a monotypic genus. As I have before shown that *Cauloglossum* is a synonym of *Podaxon*, it seems desirable to substitute a new name for the genus which may be distinguished by the following characters:

RHOPALOGASTER nov. gen. Fruiting body clavate, stipitate, traversed by a firm sub-gelatinous axil columella continuous with the stipe. Stipe firm, erect with naked base. Peridium simple, continuous with the stipe below and with the columella at the apex, more or less evanescent-indehiscent. Gleba persistent. Tramal plates extending from the columella toward the peridium. Basidia clavate, in groups, 4-spored, spores simple, borne on well-developed sterigmata.

RHOPALOGASTER TRANSVERSARIUM (Bosc). *Lycoperdon transversarium* Bosc in Gesell. Naturf. Freunde, Berl. Mag., Vol. V, p. 87, pl. VI, f. 9. *Cauloglossum transversarium* (Bosc), Fr. in Syst. Myc. III, p. 61. *Cauloglossum transversale* Fr., Cooke in Grevillea, No. 40, p. 133 (1878). *Secotium transversarium*, B. & C. in herb. Curtis.

Narrowly to broadly club-shaped, 3–7 cm. high; the distal end of the columella appearing at or near the apex, either as a shallow orbicular depression, or a slight protuberance. Peridium dirty brownish or buff yellow. When young the gleba is dirty gamboge yellow; when exposed by injury becoming dirty olive brown, eventually dark. Stem nearly white when fresh. Spores ovate-elliptical, 3.6–4.3 $\mu \times$ 5.8–7.2 μ, yellow brown, borne on long slender sterigmata. The plants grow out of the bases of living or dead trees or upon rotten wood, stumps or fallen logs, or among rubbish on the ground close by in wet pine lands. September–November. S. Carolina (Bosc, 1811, Curtis, 1857?); Santee Canal, S. C. (Ravenel); Wilmington, N. C. (Woods, November, 1880, Curtis, November, 1846); Carolina (Berkeley, 1873); Gainesville

Fla. (Ravenel, 1878); Eustis, Fla. (Thaxter, October, 1897); Tuskegee, Ala. (Beaumont, aestate, 1853).

Affinities.

In comparing *Rhopalogaster* with other genera, certain general resemblances are evident in several directions. Its gross characters have led, as has been already mentioned, to its close association with *Podaxon* in the group of Podaxaceae, which in turn have been placed by different authorities in different Gastromycetous orders. Fries, for example, as well as a majority of the earlier writers, regarded *Cauloglossum transversarium* as closely related to the species of *Podaxon* and *Secotium*, while Fischer (7), in his recent revision of the Gastromycetes (1898) has removed *Podaxon* to a new group, the Plectobasidiineae, leaving *Cauloglossum* with *Secotium* in the Hymenogastrineae.

That *Rhopalogaster* should be separated from the Podaxaceae, where, however, the other species of *Cauloglossum*, namely, *C. elatum*, *C. aegyptiacum*, and *C. novo-zelandicum*, should probably be referred, is clearly evident when one examines the structure characteristic of this group. The stipe of *Podaxon* is hollow and usually bulbous at the base; the peridium is scaly, and opens either by the falling off of the scales or simply by longitudinal cracking; capillitium threads are present, either rudimentary or well developed; the spores differ in form; and the gleba becomes a powdery mass at maturity. As all of these characters are distinctly absent in *Rhopalogaster*, and as *Podaxon* is the only one of the Plectobasidiineae which is at all similar to the type under consideration, *Rhopalogaster* manifestly cannot be included with the Podaxaceae. The only alternative group which remains to be considered is that of the Hymenogastrineae under which *Secotium* is now placed by Fischer.

According to Fischer's revision, the Hymenogastrineae include three sub-groups, the Secotiaceae including *Cauloglossum*, the Hysterangiaceae, and the Hymenogastraceae. The Secotiaceae according to Fischer's definition are characterized as follows: "Die Gleba ist von einer axilen, sterilen Columella durchsetzt, welche sich nach unten in einer Stiel fortsetzt. Die Tramaplatten gehen von der Peridie ab und sind deutlich gegen den unteren Teil der Columella gerichtet," and also "Bei der Reife löst sich meist die Peridie an ihrem unteren Rande von Stiele ab und kann sich mehr oder weniger deutlich ausbreiten nach Art des Hutes der Agaricaceen." As has been shown on a preceding page, the tramal plates in *Rhopalogaster*, on the contrary, extend from the columella toward the peridium, and the persistent peridium does not break

away in pieces. It is certain, then, that *Rhopalogaster* cannot be placed in the Secotiaceae.

The two remaining groups, the Hysterangiaceae and the Hymenogastraceae, are described by Fischer as possessing a "Gleba ohne oder nur mit kurzer, nicht bis zum Scheitel reichender Columella." This characterization, if adhered to strictly, would exclude *Rhopalogaster* from both groups, but since it seems more than probable that it is most nearly related to forms included in them, it will be necessary to examine into the structure of the different genera in order to determine, if possible, which are most nearly related to it.

In the Hymenogastraceae the resemblances to *Rhopalogaster* are to be found in the hymenial structure. In this group, especially *Hymenogaster* and *Octaviana*, the basidia are clavate, septate, and are arranged surrounding irregular chambers. The direction of the tramal plates is away from the peridium, however, and the columella is but rudimentary or entirely lacking. The genera *Rhizopogon*, *Sclerogaster*, and *Lycogalopsis* seem rather to exhibit affinities with the next great group, the Lycoperdineae.

In the Hysterangiaceae the absence of a complete columella is the most noticeable point of difference. *Gautiera* resembles *Rhopalogaster* in its irregularly chambered gleba, and in its thin peridium, which is at maturity lacking to such an extent as to expose the glebal chambers just as is shown in fig. 11 of the accompanying plate.

Gymnoglossum, a form reported by G. Massee (20) from New South Wales, is distinguished from *Rhopalogaster* mainly by the absence of a peridium at every stage of development, and by the fact that the columella does not reach more than half-way to the apex of the peridium. The points of similarity are the "irregular cavities lined with large clavate tetrasporous basidia, sterigmata elongated, slender, spores colored; stem distinct, elongated, solid, passing up into the gleba." *Protoglossum*, Mass., exhibits similar affinities to *Rhopalogaster*.

The genus *Hysterangium* shows a columella reaching almost to the apex of a well-developed peridium. A longitudinal section of an immature specimen of *Hysterangium clathroides* represented in a drawing by Rehsteiner (18) is strikingly similar to some of my sections of *Rhopalogaster*. It shows the thin flocculent peridium enclosing the stipe and gleba, and from the sterile part which is a continuation of the stipe there arise folds to form the gleba. The only essential difference in gross structure which is here apparent is due to the fact that in *H. clathroides* the columella falls short of the apex of the peridium. The basidia, how-

ever, which seem to be twisted in the drawing of Tulasne, perhaps owing to shrinkage in the specimen, bear but two spores on short sterigmata.

Protubera, Möller, and *Phallogaster*, Morgan, like *Hysterangium*, resemble *Rhopalogaster* through the presence of an incomplete columella; but although the early development of *Phallogaster* is as yet unknown, both genera appear to possess characters which should associate them much more closely with the Phalloideae than with the Hysterangiaceae.

In summing up this comparison with the three divisions of the Hymenogastrineae it is evident that *Rhopalogaster* is similar to the Secotiaceae only through the presence of a central columella running to the apex of the peridium. The differences lie in the nature of the peridium, in the origin and development of the tramal plates, and in general habit.

The Hysterangiaceae show resemblance in glebal structure, and in the origin and development of tramal plates. The differences lie rather in the basidia and spores and in the possession of only an incomplete columella.

Affinities with the Hymenogastraceae lie in the similarity of glebal characters; the differences are apparent in the lack of an axil columella, in the origin and development of the tramal plates, and in general habit.

It will thus be seen that although *Rhopalogaster* resembles the Secotiaceae and the Hymenogastraceae in certain respects, the origin of its gleba excludes it absolutely from both these families; and that, on the other hand, except for the presence of a complete columella, it may be very closely associated with forms belonging to, or at least that have been placed among, the Hysterangiaceae.

Gymnoglossum, for example, although its columella is incomplete and the peridium is said to be entirely lacking in all stages of development, seems very similar in general structure and habit as well as in the possession of tetrasporous basidia, bearing brown ovoid spores on well-developed sterigmata. *Gautiera* also offers points of resemblance in possessing an evanescent peridium, and distinct, though rudimentary, columella. The genus *Hysterangium*, to which reference has previously been made, although dissimilar in respect to its basidia and spores, possesses an almost complete, though much less clearly limited, columella; from which the glebal structures develop almost exactly as in Rhopalogaster.

Although, even excluding *Protubera* and *Phallogaster*, the Hysterangiaceae of Fischer include a somewhat miscellaneous assortment of forms, none of which present even general points of structure to which our plant can be said strictly to conform, it seems desirable, in view of the resemblances noticed, to include it in this family. It may be suggested, however, that the discovery of additional forms, or a fuller

knowledge concerning some of those already recorded, may possibly necessitate the formation of a fourth order for its reception among the Hymenogastrineae.

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EXPLANATION OF PLATE.

Figs. 1–5 inclusive are about three-fourths natural size as reduced. The remainder of the figures were drawn with a camera lucida with the magnifications indicated, and reduced one-third in the reproduction.

FIG. 1. Several young fruiting bodies on a common mycelium.

FIG. 2, 3, 4. Specimens illustrating different habits. Fig. 3 shows chambers exposed in a few places.

FIG. 5. Median longitudinal section of mature specimen. x = perid., y = col., z = gleba.

FIG. 6, 7, 8. 9. Sections of various stages. Fig. 8, × 16; Fig. 9, × 16; Fig. 6, × 12; Fig. 7, × 10.

FIG. 10. The end of columella seen from outside.

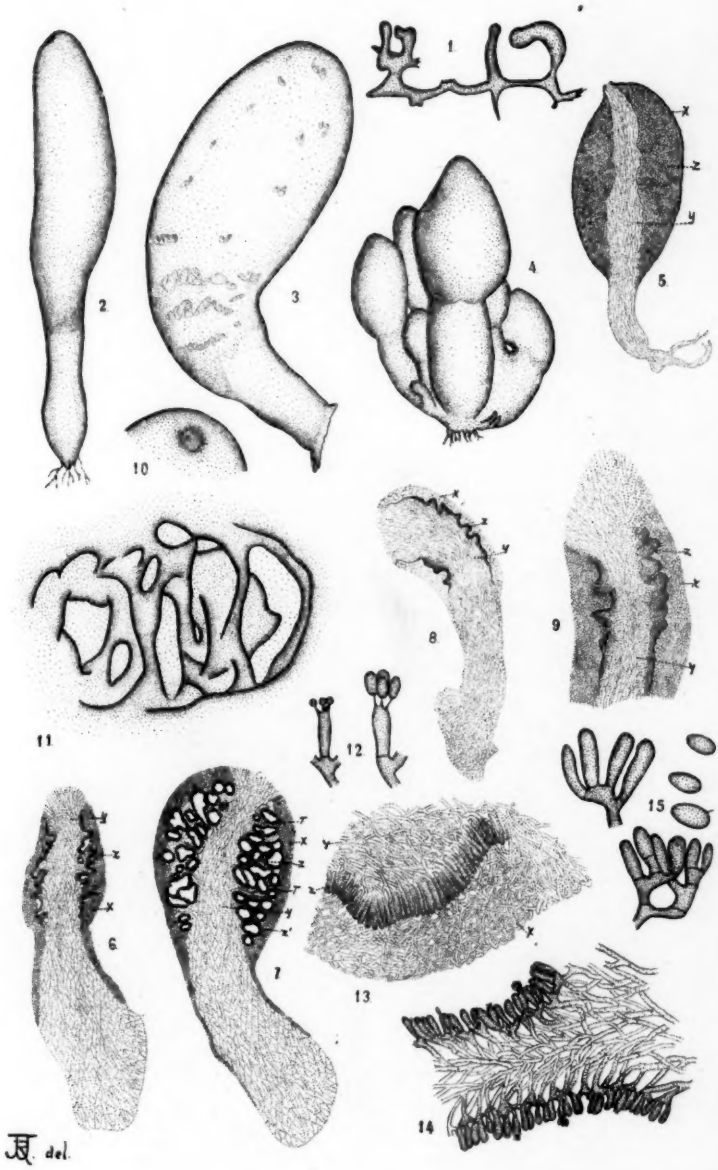
FIG. 11. Chambered structure seen from outside where peridium has opened, × 19.

FIG. 12. A young and a mature basidium bearing spores.

FIG. 13. Portion of Fig. 8. 625 diam. x, y, z, as above.

FIG. 14. Portion of chamber wall, showing trama and basidia.

FIG. 15. Groups of basidia and spores. Oc. 4., $\frac{1}{12}$ oil im.



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